

Wind Deployment Systems Model (WinDS)

BACKGROUND/OVERVIEW

The Wind Deployment Systems Model (WinDS) is a computer model, which shows expansion of generation and transmission capacity in the U.S. electric sector during the next 50 years. It minimizes system-wide costs of meeting loads, reserve requirements, and emission constraints by building and operating new generators and transmission in 25 two-year periods from 2000 to 2050.

Figure 1 shows the 358 regions in the United States represented by WinDS. As shown in **Figure 2**, WinDS disaggregates the wind resource into five classes ranging from Class 3 (5.4 meters/second at 10 meters above ground) to Class 7 (>7.0 m/s). WinDS also includes offshore wind resources.

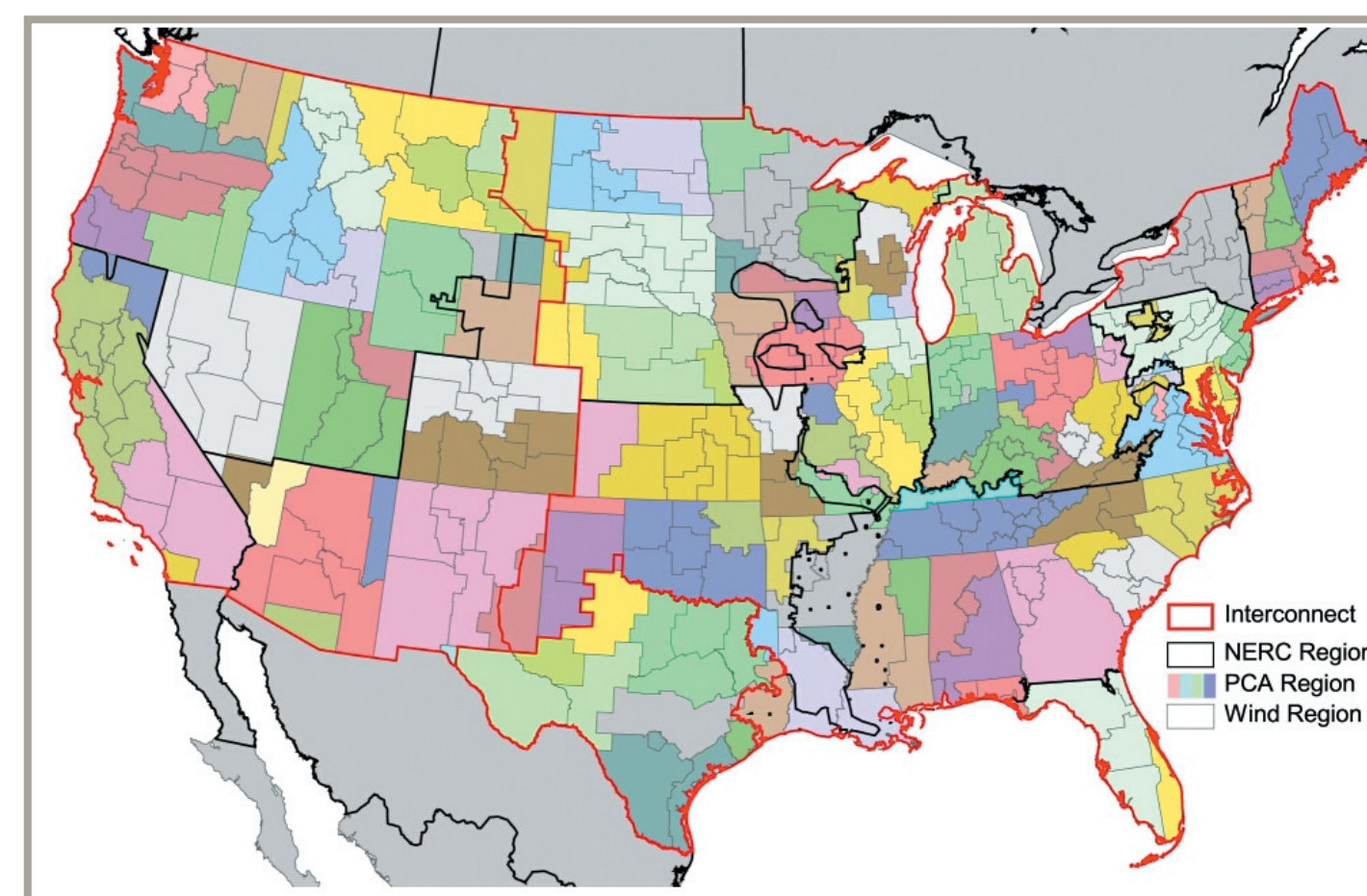


Figure 1. Regions within WinDS

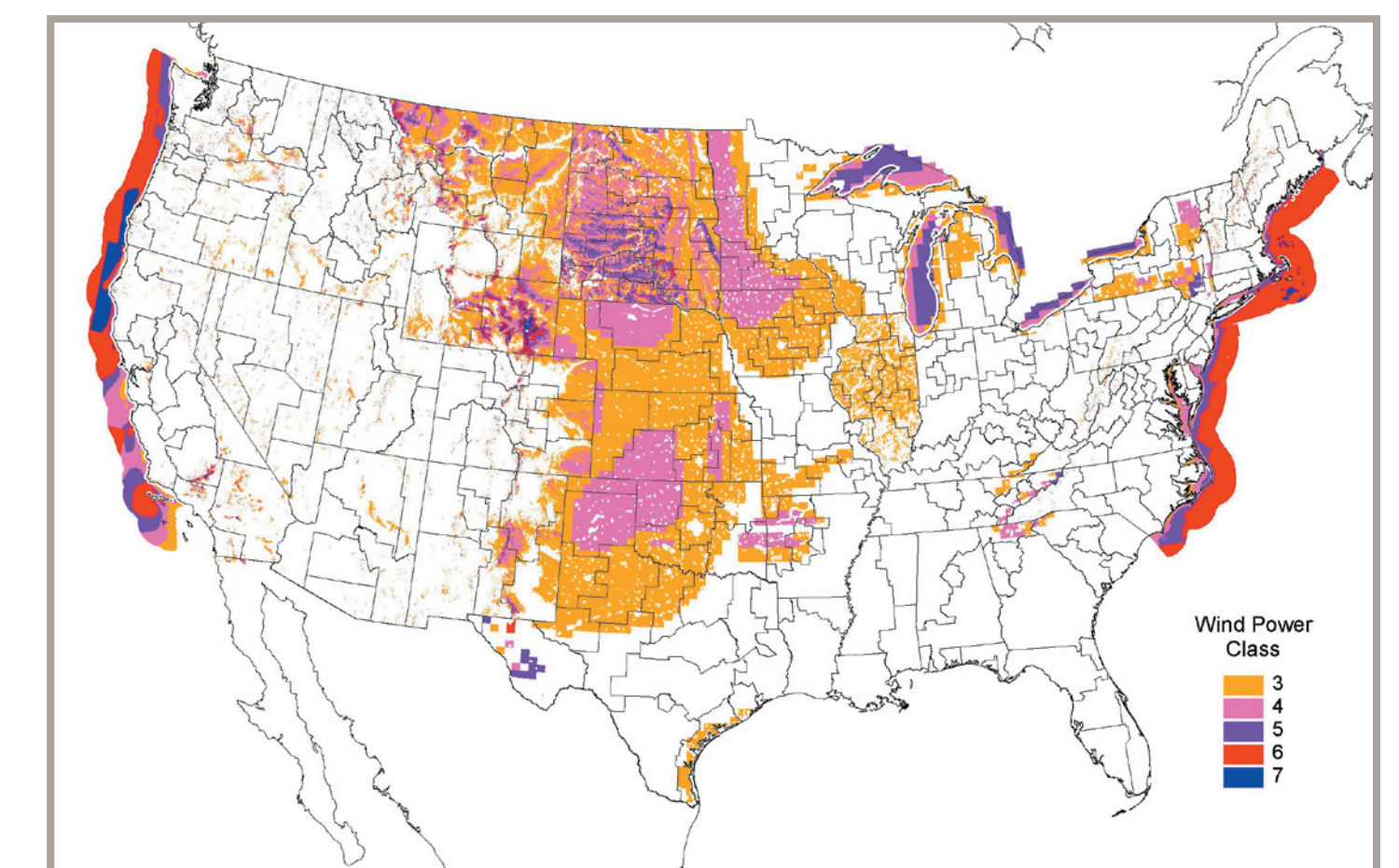


Figure 2. Wind Resources in WinDS

BASE CASE ASSUMPTIONS/RESULTS

In this analysis, the Base Case is a business-as-usual case that relies heavily on the Reference Case scenario of the U.S. Energy Information Agency (EIA) Annual Energy Outlook, using it for inputs that fall outside the scope of WinDS. This includes electricity demand, fossil-fuel prices, existing federal energy policies, and the cost and performance of non-wind electric-generating technologies (see **Figure 3**).

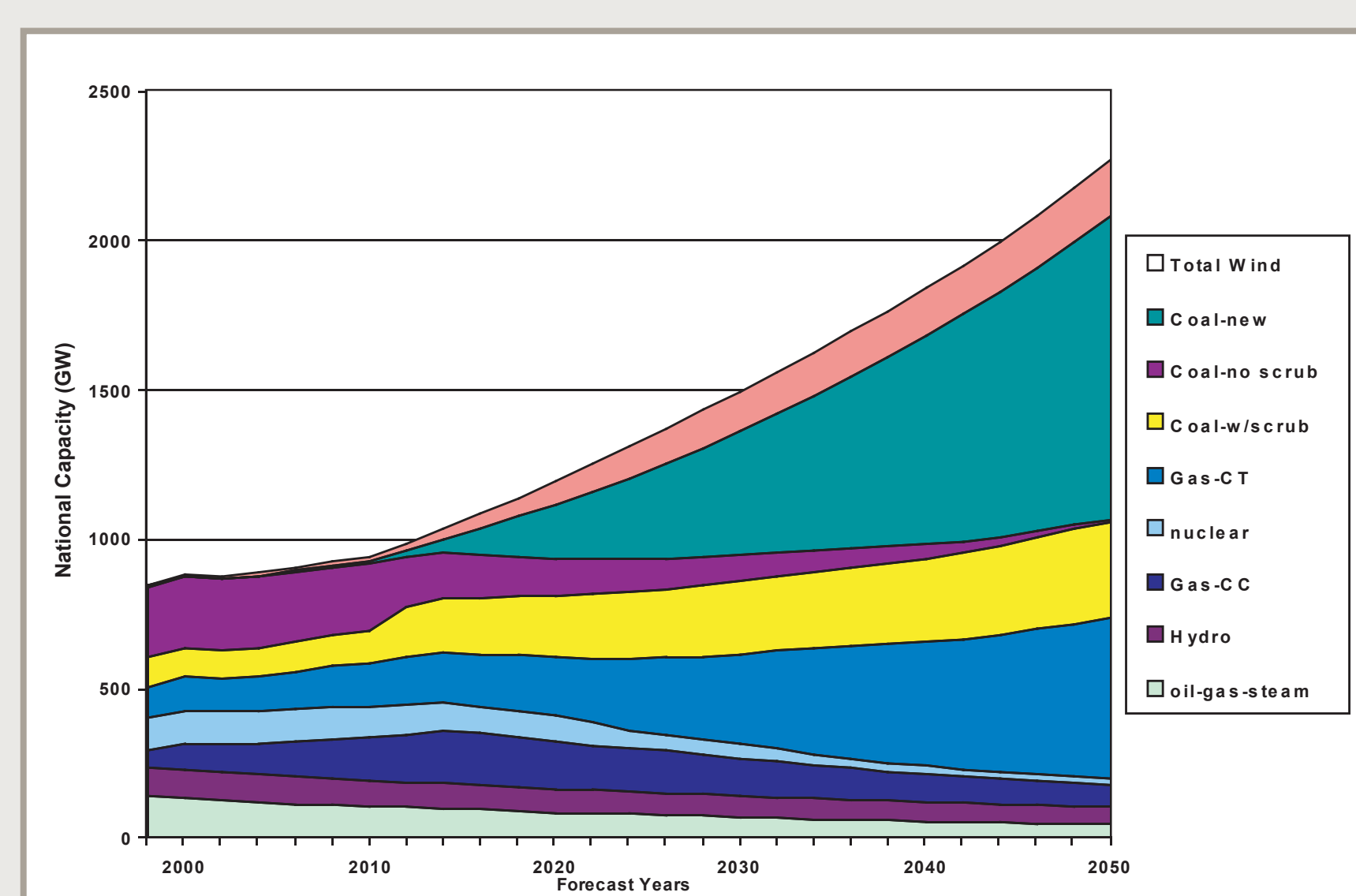


Figure 3. National Capacity Projections for the WinDS Base Case

LOCATION OF WIND CAPACITY

Figure 4 shows the location of the cumulative wind-power installations in 2050 in the Base Case scenario. As one might expect, most are located in areas with excellent wind resource — but other areas are close to load centers (such as southern California). Note also that offshore wind is represented in the closest onshore wind region on the map. Most of the wind on the East Coast is offshore wind power.

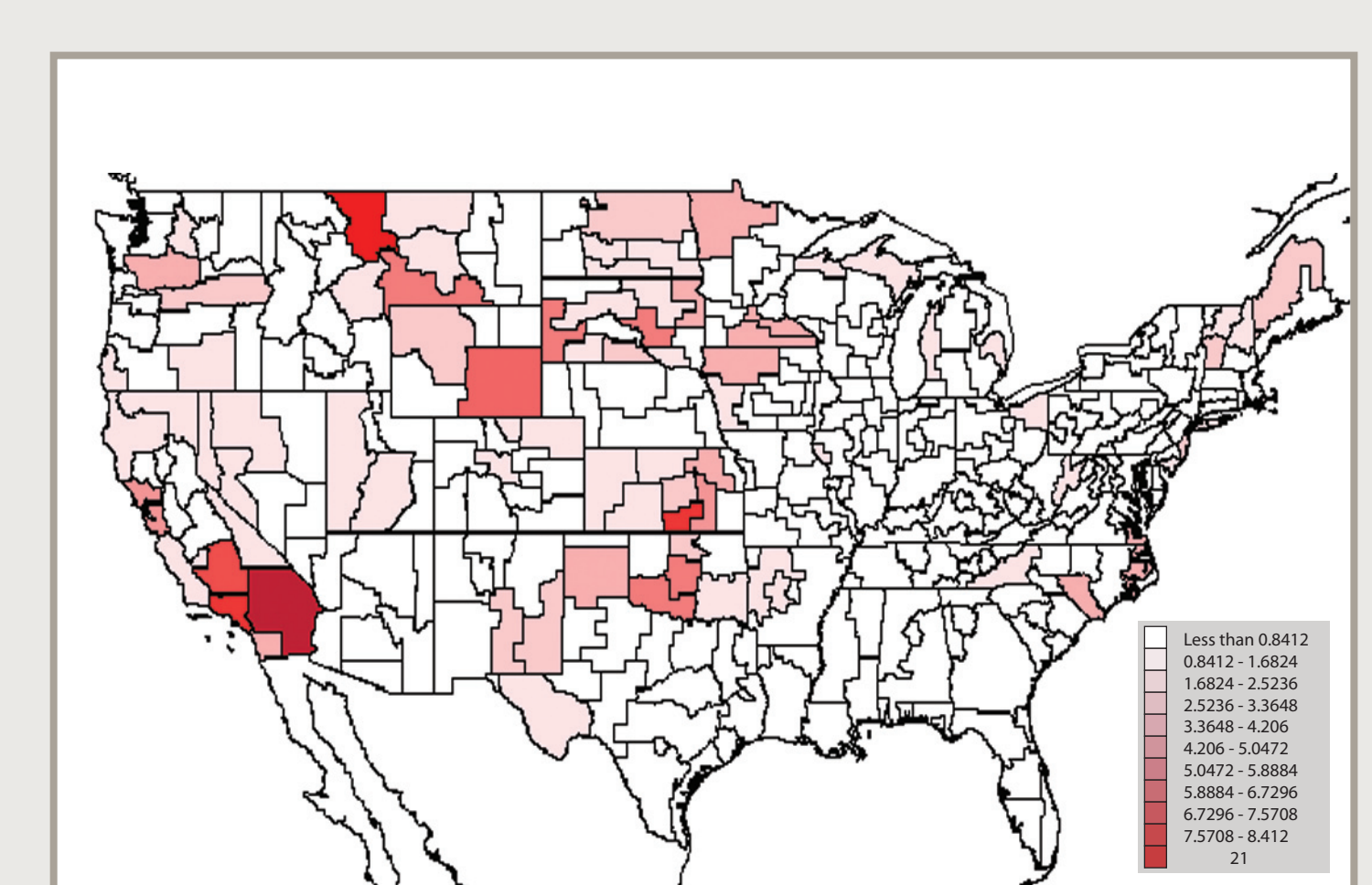


Figure 4. Location of Cumulative Wind-Power Installations in 2050 in GW

PRODUCTION TAX CREDIT (PTC) TO 2006

As shown in **Figure 5**, continuing the PTC to 2006 at \$18/MWh will significantly increase wind generation for the next 30 years. However, as might be expected, with continued R&D-driven improvements in wind turbines, the amount of wind capacity installed is the same after 30 years — with or without the PTC. Two counteracting forces lead to this result. The first — and more obvious — is that increased deployment leads to improved wind cost/performance through learning. The second is that the best wind sites are used quickly in the PTC extension case, leaving only lower-quality sites once the PTC has expired.

In **Figure 6**, which presents the same data as Figure 5 but with the scale changed, the parallelogram roughly represents the generation on which the government must pay the \$18/MWh tax credit. However, the total shaded area represents the total generation that occurs due to the PTC. For a majority of the generation, the government does not need to pay the tax credit.

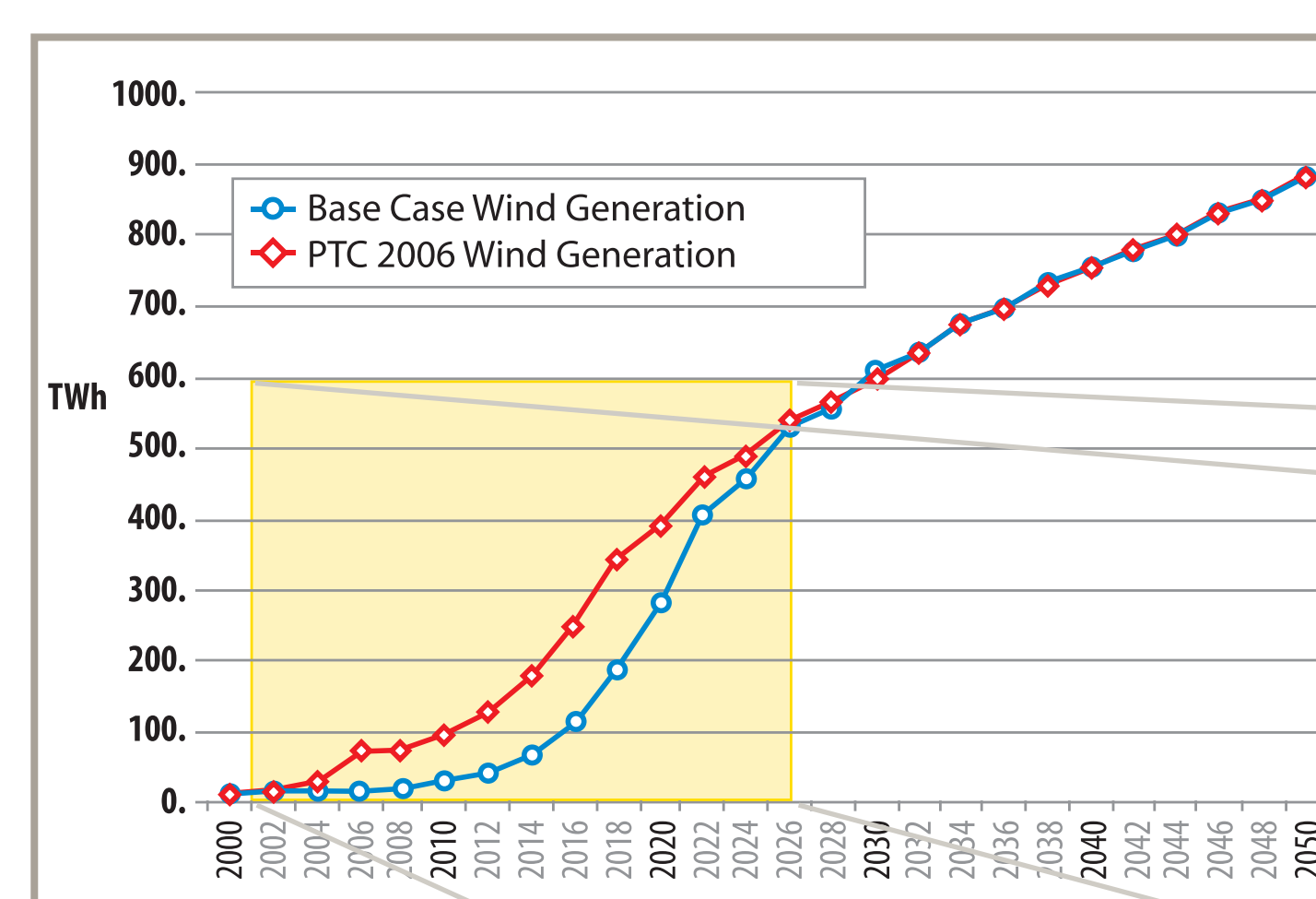


Figure 5. Wind Generation for a PTC Extension until 2006, Compared to Base Case

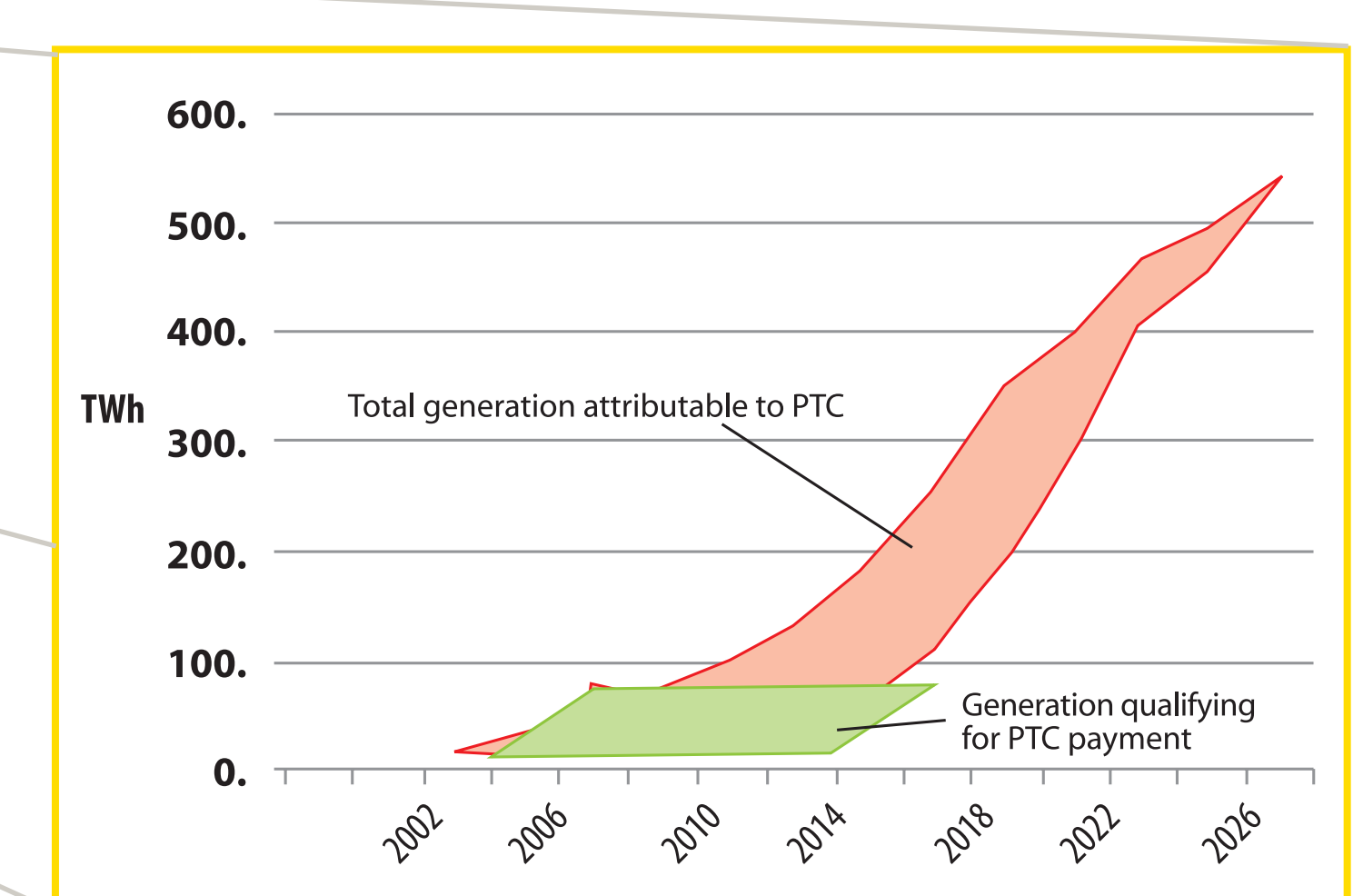


Figure 6. PTC Cost and Additional Generation

MODELING HYDROGEN PRODUCTION

WinDS can model the production of hydrogen from wind electrolysis, distributed electrolysis, and steam methane reforming (WinDS-H₂). The model, as shown in **Figure 7**, also provides for fuel cells at the wind sites and at distributed electrolysis sites. These can be used in conjunction with electrolyzers to firm up the wind power and to provide general storage to the electric grid.

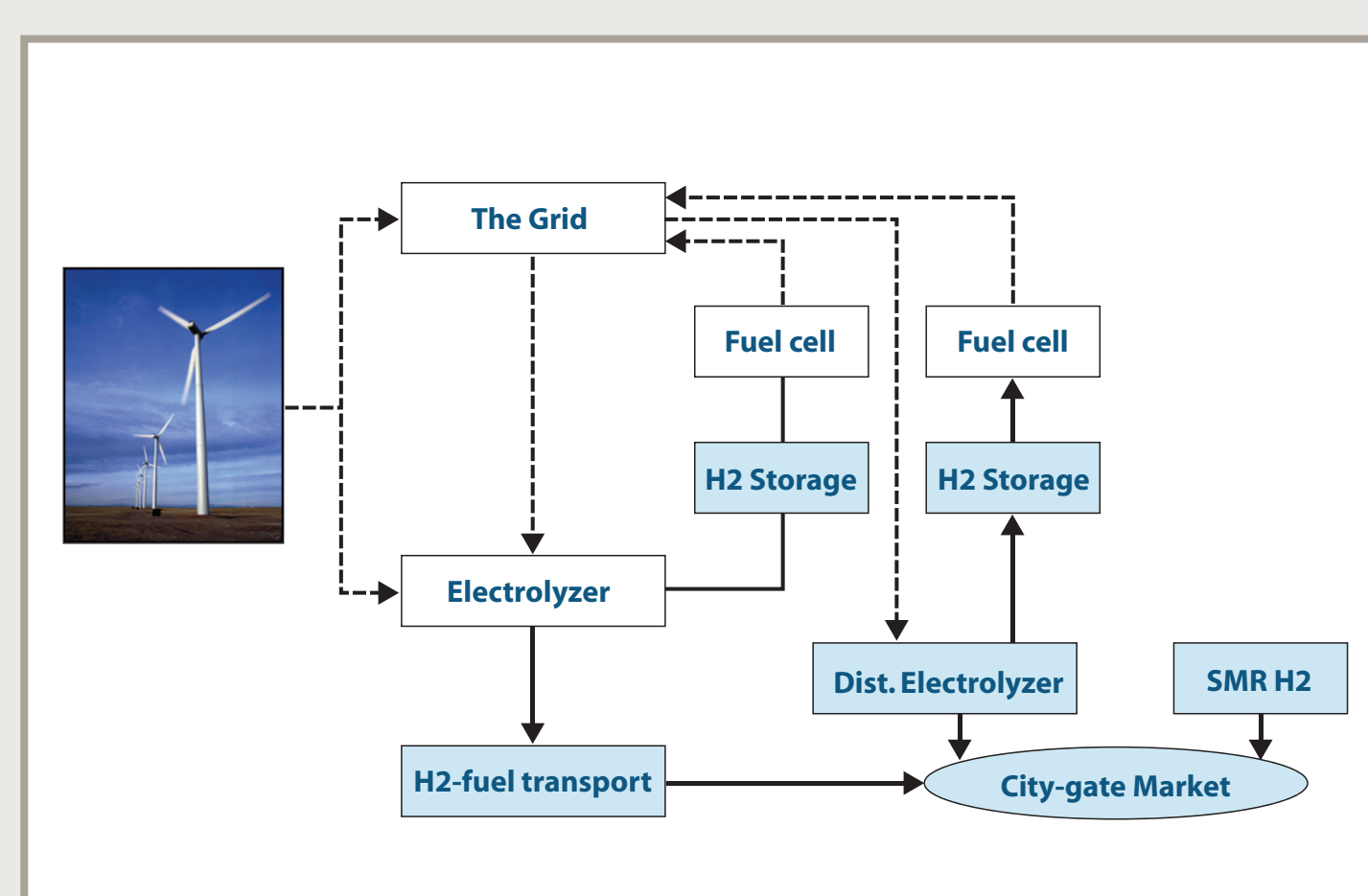


Figure 7. The WinDS-H₂ Model

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HYDROGEN TECHNOLOGY POSSIBILITIES

Figure 8 shows that for 2030, 2040, and 2050, electrolyzers and fuel cells may be economically deployed at wind sites to produce hydrogen for use as a transportation fuel and for firming the wind generation. Electrolyzers also are deployed in these years at distributed load locations. With these hydrogen technology possibilities, more wind generation is fed to the grid for two reasons: The wind generation is firmed by the fuel cell and more overall generation is needed to feed the distributed electrolyzers.

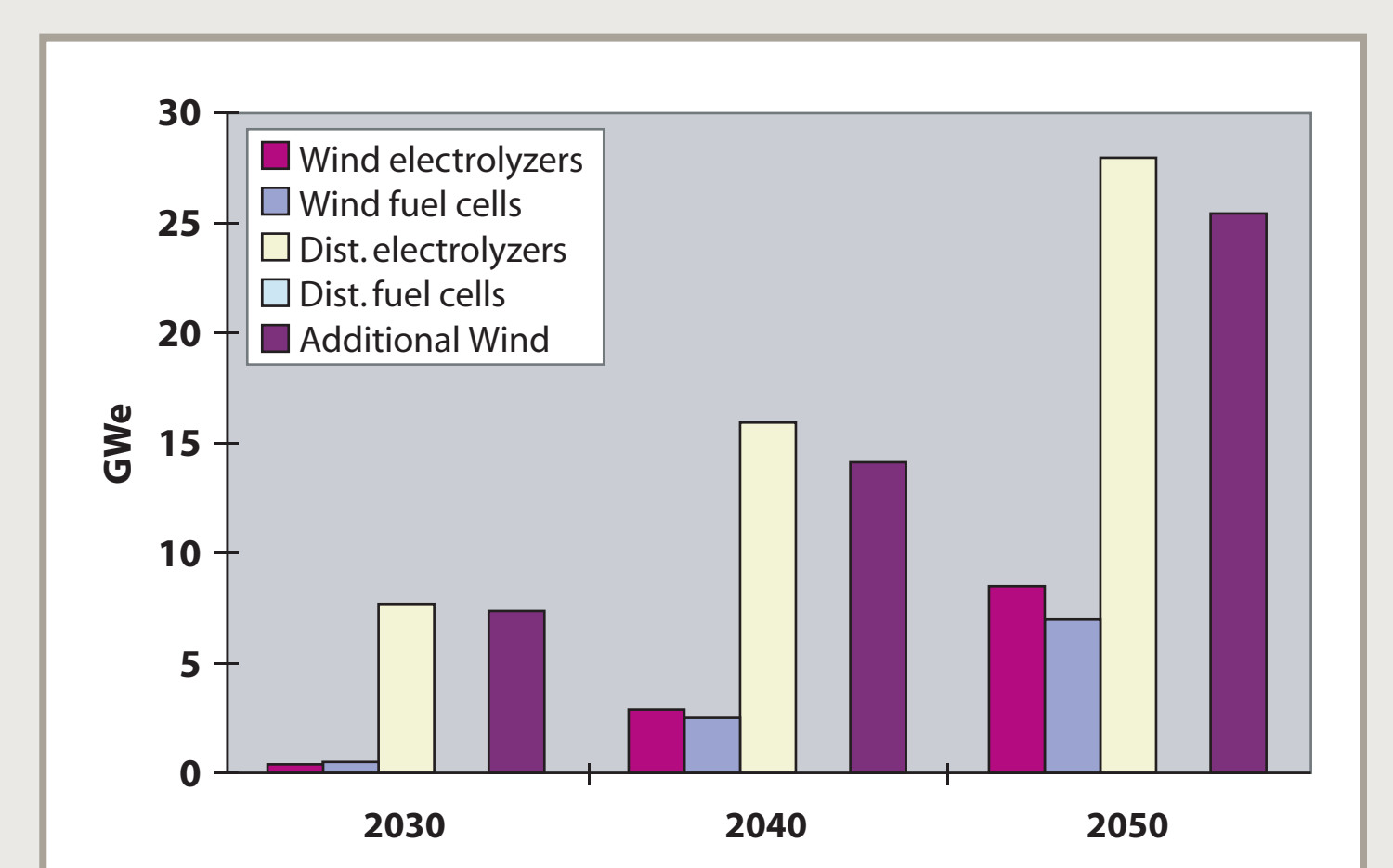


Figure 8. Deployment of Electrolyzers and Fuel Cells